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MIL SPEC 28 SQUARE FOOT FIRE BURNBACK AND EXTINGUISHMENT TESTING OF FIREADE, FLAMEOUT II AND HAWK ALLFIRE

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ABSTRACT

The Air Force, in cooperation with the Federal Aviation Administration, is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. This report documents the evaluation performed on the fire extinguishing agents FireAde 2000 AFFF LP, FlameOut II and Hawk ALLFIRE in accordance with the parameters set forth in Military Specification (MIL SPEC) MIL-F-0024385F, Section 4.7.13 for the twenty-eight-square-foot fire test using three percent of Type 3 foam (normal concentration). Under the MIL SPEC test protocol, agents were required to meet a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds for normal concentrations. None of the three agents tested at the normal concentration met these minimum requirements. Although not part of the Air Force Research Lab protocol, additional tests were performed on FireAde at the lean concentration (1½ percent). FireAde successfully passed this portion of the fire test. Lean concentration testing was not performed on the FlameOut II or Hawk ALLFIRE foams.

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SUMMARY

The Air Force, in cooperation with the Federal Aviation Administration, is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. The DoD and FAA are interested in a simple, reliable test to evaluate the effectiveness of new foams being introduced into the market as potential Aqueous Film Forming Foam (AFFF) replacements. This report documents the evaluation performed on the fire extinguishing agents FireAde 2000 AFFF LP, FlameOut II and Hawk ALLFIRE in comparison with the performance of 3M AFFF in accordance with the parameters set forth in Military Specification (MIL SPEC) MIL-F-0024385F, Section 4.7.13 for the twenty-eight-square-foot fire test using 3% of Type 3 foam. The MIL SPEC test offers a screening method to determine the extinguishment and burnback characteristics of each foam in comparison to MIL SPEC AFFF. For an agent to pass the performance requirements, it must have a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds. Of the three agents tested, none of the agents tested at the 3 percent, Type 3 met these minimum requirements. Testing showed that the FireAde 2000 AFFF LP came the closest to passing the fire test. These results were expected since FireAde contained a fluorinated surfactant and FlameOut II and Hawk did not. Even though FireAde passed the lean concentration test, the agent did not pass at the normal concentration and therefore did not pass the AFRL portion of the 28 ft² fire test. Lean concentration testing was not performed on the FlameOut II or Hawk ALLFIRE foams.

I. INTRODUCTION

A. Background

The Air Force, in cooperation with the Federal Aviation Administration, is screening new fire fighting foam concentrates to determine their effectiveness at extinguishing and resisting burnback for hydrocarbon fuel fires. Potential Aqueous Film Forming Foam (AFFF) replacements would be required to exhibit an increased level of fire fighting effectiveness above current MIL SPEC AFFF. Because many new manufacturers of Class B fire fighting foams have entered the market, the DoD and FAA are interested in a simple, reliable test to rule out those foams that do not meet minimum MIL SPEC requirements.

B. Purpose

This report documents the evaluation performed on the fire extinguishing agents FireAde 2000 AFFF LP, FlameOut II and Hawk ALLFIRE in comparison with the performance of 3M AFFF in accordance with the parameters set forth in the MIL-F-0024385F, Section 4.7.13 for the twenty-eight-square-foot fire test.

C. Scope

This evaluation of the fire extinguishing agents only includes the agent's fire extinguishment time and, when possible, burnback time, using a three percent concentration. This testing was conducted as a screening method to determine the extinguishment and burnback characteristics of each new foam in comparison to MIL SPEC AFFF. The complete 28 ft² fire test is comprised of 5 different tests including lean concentration with seawater and freshwater, normal concentration with seawater and freshwater and rich with seawater (Table 1). Type 3 foam is classified as a concentrate that is normally mixed at three parts foam to 97 parts water. Type 6 foam is classified as a concentrate that is normally mixed at six parts water to 94 parts foam. For an agent to successfully complete this requirement, all five components of the 28 ft² fire test must be passed, not just one out of the five. Because of time constraints, only the normal concentration with freshwater was tested for FlameOut II and Hawk ALLFIRE. FireAde 2000 AFFF LP was tested normal concentration with freshwater, lean with freshwater and at six percent with freshwater. All agents tested were of the Type 3 variety.

Table 1. MIL SPEC AFFF Test Concentration Values and Fire Performance.

| <i>Solutions</i> | <i>Type 3</i> | <i>Type 6</i> | <i>Maximum Extinguishment Time (seconds)</i> | <i>Minimum Burnback Time (seconds)</i> |
|------------------------------------|-------------------|-----------------|--|--|
| <i>Lean¹</i> | <i>1.5 ± 0.03</i> | <i>3 ± 0.1</i> | <i>45</i> | <i>300</i> |
| <i>Normal strength¹</i> | <i>3 ± 0.05</i> | <i>6 ± 0.1</i> | <i>30</i> | <i>360</i> |
| <i>Rich²</i> | <i>15 ± 0.2</i> | <i>30 ± 0.2</i> | <i>55</i> | <i>200</i> |

¹One test with freshwater and one with seawater

²One test with seawater

II. METHODS

A minimum of three fires was conducted for each agent to determine the agent's fire suppression and burnback resistance. These tests were conducted following the parameters and requirements set forth by Military Specification MIL-F-24385F, Section 4.7.13 for AFFF 3 percent, Type 3 (three parts concentrate to ninety-seven parts freshwater) and compared to the performance of 3M AFFF. These tests were used only as a screening process to determine if the manufacturer should continue with the complete MIL SPEC test.

All tests were conducted inside the Air Force Research Laboratory Fire Hangar, Test Range II, Tyndall AFB, FL to minimize the effects of wind on testing.

A. Equipment and Materials

The equipment used during testing included a large circular pan (28 ft², ¼ inch thick steel pan with a 4-inch high side) placed on a level surface, a smaller circular pan (1 foot, with a 2 inch side) to perform the burnback portion of the testing and a 2 gallon per minute (gpm) nozzle for foam application as specified in MIL-F-24385F, Section 4.7.5. The foam mixture was of normal strength for 3 percent, Type 3 made with freshwater. Eleven gallons of unleaded gasoline, Mogas, which conforms to the American Society for Testing and Materials (ASTM) D439, was used during each test.

FireAde 2000 AFFF LP contained a fluorinated surfactant, similar to what is found in the 3M AFFF. Fluorinated surfactants are particularly effective against hydrocarbon fuel fires. FlameOut II and Hawk ALLFIRE did not contain fluorinated surfactants but were still advertised as being effective in extinguishing hydrocarbon fuel fires.

B. Procedures

Prior to each test, all equipment was cleaned, the nozzle was verified to disburse 2 gpm of foam and a shallow layer of freshwater (approximately 1 inch deep) was placed in the bottom of the larger pan to guarantee complete coverage of the area with fuel. At the beginning of each test, ten gallons of fuel was poured into the larger pan within a 30 second period and the fuel was then ignited. After a 10 second pre burn, the fire was attacked aggressively, with agent being first applied to the center and then to the outer edges to effectively coat and extinguish the flames. The exact moment of extinguishment was recorded and foam application continued for a total of 90 seconds, which ensured a consistent foam volume for all agents for the burnback test.

C. Burnback Procedures

Within 60 seconds of the completion of the foam application, the 1 foot pan containing 1 gallon of fuel was lit, placed in the center of the larger pan and the timer started. When the fire had spread outside the smaller pan and was burning steadily, the smaller pan was removed. The burnback time was recorded as the time when 7 square-feet (25 percent) of the total area were in flames. However, intermittent "flash-overs", characterized by creeping faint blue or invisible flames over the foam

surface, were not considered part of the 25 percent of the total area. Burnback tests were only performed on agents that were able to completely extinguish the fire within the initial 90 second application time.

III. RESULTS

Each agent's performance was compared to the performance of the control agent, 3M AFFF. The results of testing fell into 2 categories: extinguishment time and burnback time. Results from each agent are shown in Table 2.

Table 2. Summary of Test Results.

| Agent | Percentage of Type 3 | Extinguishment Time | Burnback Time | Comments |
|-----------------------|----------------------|---------------------|-----------------------------|----------------------------------|
| Control Agent 3M AFFF | 3% | 0:24:00 | None Recorded | Small pan was not taken out |
| | 3% | 0:38:15 | Self Extinguished @ 6:22:31 | |
| | 3% | 0:32:35 | Self Extinguished @ 6:34:31 | |
| | | | | |
| FireAde 2000 | 3% | 0:59:40 | 9:30:00 | |
| | 3% | 1:11:00 | 8:51:05 | |
| | 6% | 0:42:57 | 8:11:50 | |
| | 1.5% | 0:41:06 | Self Extinguished @ 4:24:58 | No video for Extinguishment |
| | 1.5% | 0:44:06 | Self Extinguished @ 4:54:19 | |
| | | | | |
| FlameOut II | 3% | 2:00:00 | NA | Extinguishment time > 90 seconds |
| | 3% | 2:19:22 | NA | Extinguishment time > 90 seconds |
| | 3% | 1:51:12 | NA | Extinguishment time > 90 seconds |
| | | | | |
| Hawk ALLFIRE | 3% | DNE | NA | Did Not Extinguish |
| | 3% | DNE | NA | Did Not Extinguish |
| | 3% | | | Test not performed per previous |

A. Extinguishment

The average extinguishment time for 3 percent, Type 3 3M AFFF was 32 seconds, while the average extinguishment times for 3 percent, Type 3 FireAde 2000 AFFF LP and Flame Out II were 66 seconds and 123 seconds, respectively. Hawk ALLFIRE did not fully extinguish the fire. Because the extinguishment time for Flame Out II was greater than 90-seconds and Hawk ALLFIRE did not fully extinguish the fire, burnback could not be performed on either of these agents.

B. Burnback

The control agent, 3M AFFF, self-extinguished at 389 seconds. Self-extinguishment was determined to be the point when all flames were extinguished without further agent application. Self-extinguishment does not happen often during this test. Usually, the fire will continue to spread as the water drains from the foam and the fire consumes the foam. In this case, the foam was able to reseal itself and extinguish the fire. While none of the 3 percent, Type 3 agents tested self-extinguished, the average

burnback time for FireAde 2000 AFFF LP was 550-seconds, which exceeds the minimum requirement of 360 seconds.

C. FireAde Lean Testing

Although outside of the original protocol, and due to the thick consistency of the foam at 3 percent, two additional tests were performed on FireAde 2000 AFFF LP at 1½ percent (lean concentration). These tests resulted in an average extinguishment time of 43 seconds and an average burnback self extinguishment of 279 seconds (minimum MIL SPEC requirements are extinguishment less than 45 seconds and burnback greater than 300 seconds). By reducing the concentration of agent, the foam blanket was thinned, allowing the foam to flow more quickly and extinguishing the fire within the required time. Burnback was not affected by the lean concentration and self extinguishment was observed in both trials.

D. Summary of Results

For an agent to pass the performance requirements it must have a maximum extinguishment time of 30 seconds and a minimum burnback time of 360 seconds. FireAde, FlameOut II and Hawk ALLFIRE did not meet the minimum requirements for extinguishment and burnback at the normal concentration. Special circumstances required testing of FireAde at the lean concentration, which met MIL SPEC requirements. FlameOut II and Hawk ALLFIRE were not tested at the lean concentration because this was not part of the standard AFRL fire test protocol and neither agent was close to passing at the normal concentration.

IV. CONCLUSIONS

The fire tests performed on the fire extinguishing agents FireAde 2000 AFFF LP, FlameOut II and Hawk ALLFIRE in comparison with the performance of 3M AFFF showed that FireAde 2000 AFFF LP performed best. These results were expected since FireAde contained a fluorinated surfactant and FlameOut II and Hawk do not. Even though FireAde passed the lean concentration test, the agent did not pass at the normal concentration and therefore did not pass the AFRL portion of the 28 ft² fire test.

Reference: Military Specification MIL-F-24385F, Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF), for Fresh and Sea Water, January 7, 1992.